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Effects of Applying the PETTLEP Model on Vividness and Ease of Imaging Movement

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Abstract

This study investigated the effects of applying elements of the PETTLEP model on vividness and ease of imaging movement. Forty participants (*M*age = 23.47 years, *SD* = 4.11) completed the Vividness of Movement Imagery Questionnaire (VMIQ-2) when using PETTLEP imagery or traditional imagery. Results revealed significantly higher ease and vividness ratings for internal visual imagery (IVI) and kinesthetic imagery (KI) during the PETTLEP imagery condition compared to the more traditional imagery condition. No significant difference between conditions for external visual imagery emerged. Findings suggest that incorporating PETTLEP elements during imagery enables greater ease and vividness of movement IVI and KI.

Keywords: Imagery ability, external visual imagery, internal visual imagery, kinesthetic imagery, PETTLEP, vividness

Effects of Applying the PETTLEP Model on Vividness and Ease of Imaging Movements

Imagery is a popular technique used by athletes to enhance sporting performance (Cumming & Williams, 2012; Martin, Moritz, & Hall, 1999). It has been described as an experience that reflects actual experience in a variety of senses (e.g., sight, taste, sound) without experiencing the real thing (White & Hardy, 1998). However, the ease with which an athlete is able to image and the vividness of this imagery has been proposed to influence its effectiveness, with better imagery ability leading to more effective improvements in skill acquisition and performance (Hall, 1998). In support, Robin et al. (2007) demonstrated that individuals who image more easily experienced greater improvements in the accuracy of their tennis service return following an intervention combining imagery with physical practice compared with those who found imagery more difficult. McKenzie and Howe (1997) also reported that imagery was effective in enhancing self-efficacy for only those individuals displaying higher ease of imaging. Based on the available evidence, athletes' ability for imaging is considered to be one of the most important factors in determining the extent to which imagery is effective for achieving desired outcomes (for recent reviews, see Cumming & Williams, 2012, 2013).

Imagery ability is defined as "an individual's capability of forming vivid, controllable images and retaining them for sufficient time to effect the desired imagery rehearsal" (Morris, Spittle, & Watt, 2005, p. 60). Hall (1998) explains that everyone has the ability to generate an image but this may differ in terms of vividness, controllability, kinesthetic feelings, ease, and emotional experience. Consequently, the ability to image is multidimensional and can be reflected in a number of ways. The two main dimensions used to assess imagery ability in sport are ease and vividness (Callow & Hardy, 2005; Gregg, Hall, & Nederhof, 2005). In the present study we refer to imagery ability by these dimensions. Ease of imaging can be described as how effortlessly an individual is able to create and control an image (Hall &

Martin, 1997; Williams & Cumming, 2011), whereas vividness describes as the clarity and sharpness or sensory richness of an image (Baddeley & Andrade, 2000; Morris et al., 2005). Ease and vividness have a close association in that an individual who finds it easy to image will likely generate a vivid image (Williams & Cumming, 2011). However, ease and vividness are conceptually distinct dimensions of imagery ability when imaging the different modalities experienced during an image (e.g., visual, kinesthetic, olfactory, gustatory, auditory). As such, ease and vividness should be separately measured when assessing how well someone is able to image.

Within sport, the two main modalities of movement imagery athletes use to enhance performance are visual and kinesthetic. Visual imagery involves seeing the movement and can be experienced from two different perspectives. External visual imagery (EVI; third person perspective) involves watching yourself perform the movement as if from another person's point of view whereas internal visual imagery (IVI; first person perspective) involves viewing the movement through your own eyes as if actually performing the movement (Morris et al., 2005). Kinesthetic imagery (KI) refers to imaging the feelings and sensations associated with the movement. Although EVI, IVI, and KI have been identified as separate constructs (Roberts, Callow, Hardy, Markland, & Bringer, 2008; Williams et al., 2012), combining visual and kinesthetic imagery is thought to be most beneficial for enhancing performance, both directly and indirectly through psychological variables such as confidence (Callow & Hardy 2004). However, few studies have directly examined what specific techniques could be used to develop ease and vividness of EVI, IVI, and KI.

Within those studies examining how imagery's ease and vividness can be improved, a handful of different techniques have been suggested. Based on Lang's (1979) bioinformational theory, one approach has been to include response propositions into an image as a way to making the experience more vivid (Lang, Kozak, Miller, Levin, &

McLean, 1980). Another approach described by Calmes, Holmes, Berthoumieux, and Singer (2004) is to add more details to the imagery in layers, which has been effective at producing more vivid images during an intervention. A more recent combination of both of these techniques is known as Layered Stimulus Response Training (Williams, Cooley, & Cumming, 2013), and is effective for increasing ease and vividness of both visual and kinesthetic imagery. This technique introduces stimulus, response, and meaning propositions in stages to produce more vivid imagery that is easier to generate. Taking a fourth approach, imagery ability has also been shown to improve with practice only interventions using performance based (Rodgers, Hall, & Buckolz, 1991; Williams et al., 2013) or motivation general-mastery based (Hammond, Gregg, Hrycaiko, Mactavish, & Leslie-Toogood, 2012) imagery.

Another possible technique for improving the ease and vividness of someone's imagery can be found in the PETTLEP model (Holmes & Collins, 2001; Wakefield, Smith, Moran, & Holmes, 2013). Holmes and Collins (2001) originally proposed that incorporating seven different elements (i.e., physical, environment, task, timing, learning, emotions, and perspective) into an image can lead to more effective imagery. For example, if a male soccer player is imaging to improve his dribbling, he could wear his soccer attire, position the ball underneath his foot, and stand in the correct position (physical), while imaging on the field or in the stadium (environment). He could image dribbling in a competitive match situation (task) at his current performance standard (learning) in real time (timing), and with the relevant feelings and emotions that he would experience during the actual situation (e.g., anxiety or excitement). Finally, perspective refers to the visual perspective adopted by the individual, which should ideally match the demands of the task being imaged and/or the preferences of the individual (also see Hardy, 1997).

To date, investigations of the PETTLEP model within sport have found that incorporating more elements leads to greater performance (e.g., Smith, Wright, Allsopp, & Westhead, 2007; Wakefield & Smith, 2009), as well as improvements in confidence (e.g., Callow, Roberts, & Fawkes, 2006) and motivation (e.g., Ramirez, Smith, & Holmes, 2010). For example, Smith et al. (2007) found that combining the physical and environment elements together was more effective for improving field hockey penalty flicks compared to both a physical element only condition, and a traditional imagery condition. PETTLEP imagery combined with physical practice is also more effective compared to traditional imagery or physical practice alone (Smith, Wright, & Cantwell 2008).

Within Smith et al.'s (2008) study and others (e.g., Smith et al., 2007), the traditional imagery condition was performed by individuals sitting quietly in a room located away from the performance environment, and sometimes preceded by relaxation exercise to focus in mind. Traditional imagery also does involve certain PETTLEP elements that are common to all imagery interventions, such as task, perspective, and emotion. Based on findings comparing PETTLEP imagery to traditional imagery, Wakefield et al. (2013) have suggested the physical and environment to be the key elements which add value over and above the more traditional elements.

Underpinning the effectiveness of the PETTLEP imagery is the notion that there is some shared neural activity between motor imagery and execution (Holmes & Collins, 200; Wakefield et al., 2013). Imagery of a movement is thought to elicit similar but not completely identical neural processes to that experienced during execution of the same movement (Jeannerod, 2001). The elements of the PETTLEP model promote behavioral matching between imagery and actual movement, which in turn will hypothetically lead to more efficient shared neural activity between these cognitive processes (Wakefield et al., 2013). Wakefield et al. (2013) proposed that imagery's effectiveness depends on the similarity at the neural level with the actual movement. Regular activation of the neural pathways involved in movement execution through imagery is thought to strengthen neural connections involved in execution and result in improved performance (Jeannerod, 1999). Evidence to directly support this claim is not yet available, however as outlined above, there is considerable behavioral evidence in support of the PETTLEP model. Separate to this research is also the accumulating literature demonstrating similar activation of neural areas involved with both movement imagery and execution (Holmes & Calmels, 2008).

The concept of behavior matching proposed by Wakefield et al. (2013) is also relatively new and research has yet to specifically explain why increased behavioral matching leads to greater improvements in performance than more traditional imagery. A possibility that has not been extensively considered is whether these benefits are due to parallel increases in imagery ability. As stated previously, better imagery ability can lead to more effective imagery interventions. Researchers have already suggested that certain PETTLEP elements may be particularly helpful for improving imagery ability. Gould and Damarjian (1996) proposed that more vivid imagery may occur when an individual holds a relevant piece of sporting equipment and makes movements reflective of the task (i.e., physical). In support, Callow et al. (2006) investigated the vividness of static and dynamic imagery of a skiing task. Participants in the dynamic group incorporated the physical and environmental elements of PETTLEP imagery by wearing their skiing equipment, imaging on the snow, and moving their body side to side. The static group completed the imagery while sitting on a chair away from the snow. Results revealed that participants in the dynamic group reported higher levels of vividness compared to participants in the static group. Although these findings suggest incorporating PETTLEP elements such as physical and environment may increase imagery ability, these studies only measured vividness and did not assess other key dimensions of imagery ability including ease of imaging. Furthermore, they did not separately investigate the effects of PETTLEP imagery on the different imagery perspectives and modalities commonly used in sport (i.e., EVI, IVI, and KI).

Therefore, the purpose of this study was to extensively compare the effect of PETTLEP imagery against traditional imagery on the ease and vividness of EVI, IVI and KI of movement ability. Based on Callow et al.'s (2006) study, we predicted that incorporating the physical and environment elements of the PETTLEP model would elicit more vivid and easier to generate images regardless of the visual perspective or modality compared with more traditional imagery.

Method

Participants

Forty participants (9 males, 31 females; *M*age = 23.47 years, *SD* = 4.11) were involved in the study. Most participants engaged in mild physical activity at least once a week and had no formal experience using imagery. The majority of participants had not received any imagery training (*n* = 34). The other six had received information about imagery in a university lecture.

Measures

Demographic information. Participants provided demographic details such as their age, gender, physical activity level, and if they had received any imagery training.

Vividness of movement imagery questionnaire-2 (VMIQ-2). The VMIQ-2 (Roberts et al., 2008) is a 36-item questionnaire that measures the vividness of imaging 12 movements (e.g., walking, running, throwing a stone) in visual and kinesthetic modalities. The VMIQ-2 was thought to be the most appropriate measure as the movements lent themselves well to being applied to the PETTLEP model. Participants read a description of the movement and are then instructed to image it as clearly and vividly as possibly with their eyes closed. The movements are first imaged from an EVI perspective before imagining them from an internal visual imagery perspective, and finally from a kinesthetic modality. Ratings are made on a 5-point Likert type scale ranging from 1 *(perfectly clear and as vivid as normal/feel of movement)* to 5 *(no image at all, you only know that you are thinking of the skill)*. The scale was reversed in the current study to make it more intuitive for participants (i.e., a higher rating = more clear/vivid image). The VMIQ-2 has demonstrated good validity and is regarded as an acceptable measure of movement imagery ability. For the present study, an additional 5-point Likert type rating scale was added for each item to measure ease of imaging *(1 = very hard to see/feel, to 5 = very easy to see/feel)*. In the current study the VMIQ-2 demonstrated good reliability with Cronbach alphas of .87 or above. Cronbach alpha coefficients, reflecting the internal reliability of all three subscales for vividness and ease during the PETTLEP imagery condition and traditional imagery condition are reported in Table 1.

Imagery evaluation form. After completing the VMIQ-2 participants completed a single item indicating the extent to which they understood the imagery instructions and different modalities and visual perspectives. Responses were made on a 7-point Likert type scale ranging from 1 *(did not understand at all)* to 7 *(completely understood).*

PETTLEP evaluation form. At the end of the PETTLEP imagery condition, participants completed an evaluation form to determine how helpful the PETTLEP elements were in creating clearer and more vivid images that were easier to generate. This form was comprised of the following items: 1) imaging while adopting the physical positions and having the props reflective of the movements you imaged; 2) performing the imagery in the environment reflective of where the movements would be physically performed; 3) imaging the movements at a standard reflective of your movement capabilities; 4) imaging the movements in real time; and 5) incorporating the relevant feelings and emotions into the imagery. Participants first rated how helpful the items were for creating clearer and more vivid images, and then rated how helpful the items were in making the imagery easier to perform. All ratings were made on a 7-point Likert type scale ranging from 1 *(not at all helpful)* to 7 *(very helpful)*.

Procedures

After receiving ethical committee approval for the study, participants were given an information letter explaining the nature of the study and were informed that their participation was voluntary and they could withdraw at any point. Those who agreed to participate signed the consent form at the beginning of their first visit and were asked to provide demographic information. Participants were then given the following imagery definition:

> Imagery is an experience that mimics real experience. We can be aware of "seeing" an image, feeling movements as an image, or experiencing an image of smell, tastes, or sounds without actually experiencing the real thing. Sometimes people find that it helps to close their eyes. It differs from dreams in that we are awake and conscious when we form an image (White & Hardy, 1998, pp. 389)

Next, participants were educated about the different perspectives and modalities (external visual imagery, internal visual imagery, and kinesthetic imagery) and verbally confirmed they understood the difference between the three imagery types. The participants were then randomly assigned to the counterbalanced order in which they completed the VMIQ-2 under two different conditions 24-48 hours apart. The conditions were PETTLEP imagery and traditional imagery.

During the PETTLEP imagery condition, participants were instructed to incorporate all of the PETTLEP elements when imaging each movement of the VMIQ-2 except for perspective. For the perspective element, participants were told to follow the instructions given in the VMIQ-2 instructions (i.e., image all items using EVI, followed by IVI and then KI). The PETTLEP condition instructions asked participants to adopt the physical position related to each movement described in the VMIQ-2 with props/visual aids provided as appropriate. The participants were also asked to image in an environment reflective of where the movement would be physically performed, image in real time, and incorporate any relevant emotions. For example, when imaging running up the stairs (VMIQ-2 item 5), participants would perform the image standing at the bottom of the stairs wearing appropriate attire and shoes for this activity. Similarly, when imaging kicking the ball in the air (VMIQ-2 item 11) participants held a ball while standing outside wearing the appropriate attire. See Table 2 for an explanation of how the PETTLEP elements were incorporated into the imagery.

During the traditional imagery condition, the participants completed the VMIQ-2 in the traditional imagery format. This included imaging while sitting on chair in a quiet room away from the environment where the movements would be typically performed. They also had no props or visual aids.

Once the VMIQ-2 was completed, participants assessed their imagery experience using the Imagery Evaluation Form, and in the case of the PETTLEP imagery condition, participants also completed the PETTLEP evaluation form. Finally, at the end of the second visit participants were debriefed on the nature of the study and thanked for their participation. Both sessions took no longer than one hour.

Data Analyses

Data were first inspected for missing values. Descriptive means and standard deviations, as well as the internal reliabilities of each of the VMIQ-2 subscale across the two conditions were calculated. A paired samples t-test was conducted to establish that there were no differences between conditions in how well participants understood the instructions.

For the main analyses, bivariate correlations were first run to determine the relationship between ease and vividness scores for external visual imagery, internal visual imagery, and kinesthetic imagery. Because the relationships between these dimensions were high for the subscales, repeated measures MANOVAs were used to determine differences when comparing PETTLEP versus traditional imagery.

For these analyses, Pillai's trace was reported because it is the most robust to violations of the homogeneity of the covariance matrix assumption (Olson, 1976). Mauchly's test of Sphericity was reported to demonstrate the equality of the within subject variance. When this test was significant, the Greenhouse-Geisser correction was applied to reduce the degrees of freedom (Greenhouse & Geisser, 1959). Pairwise comparisons were made using LSD post hoc analyses and Bonferroni adjustment to the VMIQ-2 subscales to control Type 1 errors when using multiple comparisons. Effect size and observed power were reported for all main effects.

Results

Preliminary Analysis

The data was first examined for any missing values. As the pattern of missing data was completely at random, these values were replaced with the mean. Internal reliability, means, and standard deviations for each VMIQ-2 subscale during both conditions are presented in Table 1.

Imagery instructions. To ensure that participants understood the instructions and different modalities and visual perspectives equally in both conditions, a paired sampled t-test was conducted. Analysis revealed that all participants understood the instructions they were given in both the PETTLEP (M = 5.65, SD = 1.31) and traditional imagery condition (M = 5.17, SD = 1.24) and no significant differences existed between conditions (t = -.22, p = .83).

Main Analysis

External visual imagery. A repeated measures MANOVA revealed that there was no significant multivariate effect between the PETTLEP imagery condition and traditional imagery condition, Pillai's trace = .07, $F(2, 38) = 1.49$, $p = .239$, $\eta_p^2 = .07$, observed power = 30%. The finding demonstrates a moderate effect size and a low observed power.

Internal visual imagery. Results of the repeated measures MANOVA revealed a significant multivariate effect, Pillai's trace = .44, $F(2, 38) = 14.90$, $p < .001$, $\eta_p^2 = .44$, observed power = 100%. At the univariate level results indicated a significant difference between PETTLEP imagery and traditional imagery for vividness, $F(1, 39) = 24.76$, $p < .001$, $\eta_p^2 = .39$, observed power = 100% and for ease $F(1, 39) = 5.22$, $p = .028$, $\eta_p^2 = .12$, observed power = 61%. Ease and vividness ratings were higher during the PETTLEP condition compared with the traditional condition. The means and standard deviations for both conditions are reported in Table 1.

Kinesthetic imagery. A repeated measures MANOVA revealed a significant difference at the multivariate level, Pillai's trace = .21, $F(2, 38) = 4.97$, $p = .012$, $\eta_p^2 = .21$, observed power = 78%. Findings at the univariate level demonstrated significant differences between the PETTLEP imagery and the traditional imagery for vividness, $F(1, 39) = 8.71$, $p = .005$ $\eta_p^2 = .18$, observed power = 82% and ease, $F(1, 39) = 9.67$, $p = .003$, $\eta_p^2 = .20$, observed power = 86%. Ease and vividness ratings were higher during the PETTLEP condition compared with the traditional condition. Means and standard deviations can be found in Table 1.

PETTLEP evaluation. Two separate repeated measures ANOVAs were conducted to compare the perceived helpfulness of the different PETTLEP elements in creating clearer and more vivid imagery that was easier to generate.

The analysis for clear and vivid imagery revealed a significant difference between the elements, $F(3.06, 119) = 4.61$ p = .004, $\eta_p^2 = .11$, observed power = 89%. Post hoc analyses revealed that participants found adopting the physical characteristics of the task significantly more helpful ($p < .01$) than any other PETTLEP elements (i.e., imaging in the environment, the reflective movement capabilities, in real time, and including the feelings and emotions relevant for the task). However, there were no differences between any of the other PETTLEP elements in their perceived helpfulness.

The analysis for ease of imaging showed a significant difference, $F(4, 156) = 3.68$, $p = .007$, $\eta_p^2 = .09$, observed power = 87%. Post hoc analyses revealed that participants found adopting the physical characteristics of the task and imaging in the appropriate environment to be significantly more helpful ($p < .05$) than using the other elements described above. There was no difference in how helpful participants found the physical and environmental elements. Means and standard deviations of how helpful all elements were for vividness and ease are reported in Table 4.

Discussion

The present study investigated the effects of applying elements of the PETTLEP model (Holmes & Collins, 2001) on ease and vividness of EVI, IVI, and KI. It was hypothesized that imagery incorporating PETTLEP elements would increase participants' ease and vividness of imaging movements using EVI, IVI and KI. Preliminary analysis demonstrated participants' understanding of the instructions and the differences between EVI, IVI, and KI. Therefore, we can be confident that ease and vividness ratings represent the influence of PETTLEP on these types of imagery.

Overall findings mostly supported the hypotheses. Incorporating more PETTLEP elements resulted in greater ease and vividness of IVI and KI compared to traditional imagery. This data provides empirical support for Callow et al.'s (2006) and Gould and

Damarjian's (1996) assertion that imagery carried out whilst dressed in the proper attire, holding relevant equipment, and standing in the environment (i.e., incorporating the physical and environment elements of the PETTLEP model) leads to a more vivid image. The present study also provided evidence that PETTLEP imagery also leads to easier to generate IVI and KI.

Previous studies (Calmes et al., 2004; Hammond et al., 2019; Rodgers et al., 1991; Williams et al., 2013) have reported the effectiveness of different imagery interventions for improving vividness and ease of image generation by drawing attention to response propositions and building images in layers. Our findings also give insight into how PETTLEP imagery can increase the effectiveness of imagery interventions and could be compared to these techniques in future research. As the ease of image generation and vividness of the image are well known factors augmenting the benefits of using imagery, we propose that a mechanism through which PETTLEP imagery operates is by enabling individuals to improve these dimensions of imagery ability (Cumming & Williams, 2012, 2013). The addition of PETTLEP elements during imagery is believed to enhance the shared neural activity between imagery and physical execution. As explained by Wakefield et al. (2013), any changes in neural activity due to the behavioral matching occurring from PETTLEP imagery has not yet been directly established, but the extant behavioral evidence is supportive of this idea.

Participants in previous studies demonstrating PETTLEP imagery to be effective (e.g., Smith et al., 2007; Wakefield & Smith, 2009) may have also experienced a boost in the ease of image generation and vividness from the addition of PETTLEP elements over and above what would be expected from traditional imagery alone. However, these dimensions have rarely been assessed during or after a PETTLEP imagery intervention has been completed. We urge future researchers to monitor changes in these dimensions in future

PETTLEP imagery interventions to determine if the increases in ease and vividness found in the current study could produce more long-lasting effects throughout a PETTLEP intervention. This information would also help to better determine the specific role played by imagery ability in determining the effectiveness of an intervention (e.g., as a mediator or moderator; see Cumming & Williams, 2013). As well, such research would also provide further evidence that PETTLEP imagery can be used as a specific technique to enhance a participant's ability to more easily generate and control, vivid and clear IVI and KI images reflective of the task.

Although there was a trend in the predicted direction, PETTLEP imagery did not lead to significantly higher ease or vividness of EVI over traditional imagery. To our knowledge, researches have yet to separately examine the effects of PETTLEP imagery on IVI and EVI. The majority of PETTLEP studies thus far have either instructed participants to use a combination of IVI and KI (e.g., Smith et al., 2008; Wakefield, & Smith; 2009, Wright Hogard, Ellis, Smith, & Kelly, 2008) or did not specify which visual perspective the athletes should adopt (e.g., Wright & Smith, 2009). The lack of a significant difference between conditions when using EVI might be due to the nature of the task being imaged (Hardy, 1997), participants' preferences for using a particular visual perspective (Callow & Roberts, 2010), or the sample size. Regardless, it is also important for future research to determine whether other techniques may be effective for enhancing EVI. Action observation is particularly relevant to consider given that this cognitive process also activates similar neural activity to both imagery and observation (Clark, Tremblay, & Ste-Marie, 2003). Action observation has also been shown to improve ease of imaging EVI (Williams, Cumming, & Edwards, 2011; Wright, McCormick, Birks, Loporto, & Holmes, 2014), and athletes who use observational learning more tend to display higher levels of imagery ability (Williams & Cumming, 2012).

It is noteworthy that the present study also explored participants' perceptions of the helpfulness of the different PETTLEP elements for generating more vivid movement images. All of the elements were perceived to be helpful to some extent, which therefore supports the suggestion for individuals to combine multiple PETTLEP elements within the same intervention (Holmes & Collins, 2001). However, we were also interested to learn whether certain elements were considered to be more helpful than others. Aligned with the available research findings (e.g., Smith et al., 2007), participants in the present study perceived the physical and environment elements as the two most helpful for creating vivid images that are easier to generate. For example, the sport-specific group (i.e., participants imaging with the physical and environment elements as well as the other PETTLEP elements) in Smith et al.'s study experienced greater performance gains compared with clothing group who did not image in the environment (i.e., included the physical but not the environment element). This previous finding suggests that greater similarity of the imagery to the real life physical and environmental details would help the imager to generate more vivid imagery. Adding to the emerging evidence demonstrating the importance of the physical and environment elements, our findings also indicate these have a role to play in increasing the ease of image generation and vividness of the image. It also suggests that individuals are aware of the elements or techniques that may lead to longer terms improvements in these dimensions of imagery ability. Future research might also explore whether the physical and environment elements lead to greater imagery ability and outcomes compared to other elements, and whether these effects depend on the content and/or function of the imagery.

From an applied perspective, athletes should be encouraged to incorporate both elements into their imagery as much as possible (for detailed advice, please see Wakefield & Smith, 2012). For physical, this could be as simple as incorporating kinesthetic sensations akin to the real life situation as well as the tactile sensations of wearing the appropriate sporting attire and touching the relevant equipment (e.g., a swimmer dressed in a bathing suit and goggles whilst standing on the starting block). For environment, the imagery would ideally take place in the location where performance will occur. However, if this is not possible, the stimulus information from the environment can be provided via photographs, video and audio recordings, and maps (e.g., an orienteer who studies topographic maps and weather reports to understand the geographical conditions of their next competition before previewing it through imagery).

To address the research question posed in the present study, the VMIQ-2 was modified to include dimensions of both vividness and ease. Although conceptually distinct, ease and vividness ratings were highly correlated with each other (> .70) and the effectiveness of PETTLEP imagery on IVI and KI ability compared with more traditional imagery was similar for both dimensions. Together, these findings suggest that participants do not distinguish between vividness and ease dimensions when completing measures such as the VMIQ-2. This issue has been previously pointed out by Williams and Cumming (2011), and highlights the importance for future research to establish whether these dimensions indeed reflect different aspects of an individual's imagery ability, and if so, whether these can be tapped by the same imagery ability instrument.

A further limitation of the study is that participants may have spontaneously engaged in certain PETTLEP elements beyond what they were instructed to do within the traditional imagery condition. For example, participants in the traditional imagery condition were not told to image in real time (timing) and with the appropriate attentional demands required (task). However, it is possible for participants to have carried out their imagery in this manner without the researchers being aware due to the covert nature of the experience. This issue is not unique to the present study but is problematic with all research comparing PETTLEP imagery to more traditional imagery. Another limitation to note is the measurement of imagery ability and helpfulness of the PETTLEP elements were self-report. Although questionnaires are the most common way to assess movement imagery ability, other complementary techniques have been employed including chronometric and brain imaging techniques (e.g., Guillot et al., 2008; Malouin, Richards, Durand, & Doyon, 2008). Rather than just reply on self-report measures, we encourage future researches to combine a range of indices to provide a more comprehensive measure of imagery ability (also see Collet, Guillot, Lebon, MacIntyre, & Moran, 2011).

In conclusion, the present study demonstrated that PETTLEP imagery's effectiveness is likely to be explained through increasing both the ease and vividness of IVI and KI. However, PETTLEP imagery did not significantly increase EVI compared with more traditional imagery. Therefore, coaches and athletes should be encouraged to apply PETTLEP imagery during an imagery session when using IVI and KI imagery. Although there were no significant differences for EVI ease and vividness during PETTLEP and traditional imagery, it is unknown whether EVI PETTLEP imagery is more beneficial than traditional imagery through other mechanisms. Future research should compare other techniques thought to improve imagery ability such as action observation to investigate whether PETTLEP imagery or action observation is more effective at improving ease and vividness of athlete EVI, IVI, and KI.

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Table 1

Internal reliability, mean and standard deviation of EVI, IVI and KI for vividness and easiness of both conditions

	PETTLEP imagery						Traditional imagery					
	Vividness			*Ease*			*Vividness*			*Ease*		
	α	*M*	*SD*	*α*	*M*	*SD*	*α*	*M*	*SD*	*α*	*M*	*SD*
EVI	.89	3.94	.68	.89	3.98	.69	.92	3.78	.74	.93	3.75	.81
IVI	.91	4.00*	.70	.88	4.00*	.64	.91	3.74	.69	.91	3.68	.75
KI	.87	3.83*	.71	.89	4.00*	.70	.95	3.48	.85	.95	3.56	.88

Note. * = significantly higher than traditional imagery at $p < .05$

Table 2

Description of PETTLEP elements in the imagery

PETTLEP elements	Description
Physical	Wearing the appropriate clothes during imagery or as same as the task, and holding any associated props
Environment	Image at the place as similar as possible to the task.
Task	This is related to the content of the imagery at the appropriate skill level (e.g., attentional demands) and the personal preferences.
Timing	Imaging the movement in real time reflective of the actual movement.
Learning	Imagery content should be modified and adapted to reflect any learning or improvement that takes place.
Emotion	Incorporating the feelings and emotions in imagery that are reflective of the actual movement or task.
Perspective	The viewpoint adopted by the imager during imagery

Table 3

Correlations between Vividness and Easiness in both conditions

a) PETTLEP condition	EVI Easiness	IVI Easiness	KI Easiness
EVI Vividness	**.87****	.64**	.51*
IVI Vividness	.54**	**.80****	.53**
KI Vividness	.37*	.59**	**.88****
b) Traditional condition	**EVI Easiness**	**IVI Easiness**	**KI Easiness**
EVI Vividness	**.87****	.73**	.54*
IVI Vividness	.64**	**.95****	.64**
KI Vividness	.56**	.67**	**.77****

Note. * p = .001, ** $p < .001$.

Table 4

Means and standard deviations of perceived helpfulness of PETTLEP elements

Items	Vividness		Easiness	
	M	*SD*	*M*	*SD*
1. **Imaging while adopting the physical positions and having the props**	6.07*	1.04	6.00*	.88
2. **Performing the imagery in the environment reflective**	5.48	1.22	6.03*	1.40
3. **Imaging the movements at a standard reflective of your movement capabilities**	5.42	.71	5.57	.99
4. **Imaging the movements in real time**	5.35	1.19	5.45	1.10
5. **Incorporating the relevant feelings and emotions into the imagery**	5.27	1.24	5.5	1.10

Note. Items completed one of two possible stems: "How helpful were the following things in creating clearer and more vivid images…" or "How helpful were the following things in making the imagery easier to perform…"
*$p < .05$ = significantly more helpful than the other elements.